The Potential and Constraints of Wind Farm Development at Nearshore Sites in the Maltese Islands

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SUMMARY

The electrical energy requirements of the Maltese Islands are met in their entirety by two oil-fired electrical generation plants. In view of this complete dependence upon fossil fuels, investigations into the prospects of diversifying electrical generation by resorting to renewable energy technologies are particularly relevant. The archipelago has peculiar characteristics such as high population density, comparatively deep coastal waters and an economy based on tourism, manufacturing, marine-sector activities and services that make the integration of wind power generation projects challenging. Local government authorities commissioned the authors to assess the constraints related to wind farm development in a shallow water coastal area, known as *is-Sikka l-Bajda*, which could present a wind potential worth exploiting, and to recommend adequate mitigation measures to minimize any impacts and conflicts with stakeholders. These constraints include marine navigational aspects, fishing and aquaculture, tourism and other site-specific activities. Environmental constraints exist including the fact that the site is characterized by extensive seagrass (*Posidonia oceanica*) meadows, that it is a priority habitat under the EU Habitats Directive, and that the site itself is a reef - another priority habitat within the same directive. The proposed near-shore site is also in the vicinity of a protected coastal bird rafting and bird nesting site for the Yelkouan Shearwater species. Submarine noise generation - particularly during the construction phase - is also of concern in view of the regular sighting of marine mammals in Maltese coastal waters. In the site evaluation exercise, another secondary site in the Maltese Islands, located off the north Gozo coast, was also assessed. Mitigation measures specific to the *Sikka l-Bajda* site proposed by the authors include the deployment of silt curtains, bubble screens and unobtrusive turbine lighting devices and avoiding utilisation of the reef area closest to the protected bird colony. Such measures also relate to the choice of the array design to minimise visual impact and to the period of the year when wind plant construction and deployment should take place to minimize impact on avifaunal populations. By declaring the marine area contiguous to the proposed nearshore wind facility development as off-limits to fishing vessels, a de facto 'No-take' Marine Protected Area can also be effectively instituted. One also expects submerged components of the nearshore wind facility to be colonized within a brief period by a diverse fouling community and that the same components act as Fish Aggregating Devices (FAD's), greatly enhancing

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fish populations in the area. In view of the current paucity in Mediterranean nearshore wind power facilities, the proposed project could potentially serve as a pilot project for the whole region, and also become a tourist attraction.

Keywords: Malta, Wind Farms, *Is-Sikka l-Bajda*, Nearshore.

1. PURPOSE OF WORK

The Maltese archipelago consists of a number of islands and islets located in the central Mediterranean Sea. The three inhabited islands are Malta, Gozo and Comino, with a cumulative land area of 315.6 square kilometres. Geographically located mid-way between southern Europe to the north and Africa to the south, the island group forms part of the European Union. The Republic of Malta has a very high population density with an average 1,298 persons per square kilometre [1]. The islands are characterised by low lying land on the north eastern sides and steep coastal escarpments along most of their south westerly seaboards. The north east coastline is indented by a number of bays and natural harbours whilst the latter coastal stretch is less accessible and has deep seas very close to the coast.

Electrical energy comes from two fossil fuel-powered stations having a combined nominal installed capacity of 571 MW. The two stations and the electrical distribution network are administered by Enemalta Corporation [2]. The domestic sector [3] accounts for 36% of the average electrical energy consumption, followed by the commercial (32%) and industrial sector (30%). The remainder is consumed by street lighting. The islands' electrical generation and distribution systems are, so far, not interconnected to other networks.

The renewable energy (RE) options available are quite limited and RE sources such as hydropower and tidal energy do not have a significant potential in the Maltese context. At this point in time, immediately available and sustainable electricity generating technologies are limited to onshore and offshore wind energy conversion, solar photovoltaics and solar thermal energy, and biomass. The available options, criteria for choice and potential yield have been reported elsewhere [4, 5].

Malta continues to depend completely on imported fossil fuels for electricity generation purposes; a scenario that leaves the nation exposed to oil price fluctuations on the international market and insecurity of supply. Malta's target is to attain 10% of final energy consumption from RE sources by the year 2020 [6]. In a 'business as usual' scenario where no remedial measures are taken, the country's carbon emissions are also set to continue rising.

Diversification of energy sources and of technologies is undoubtedly the best way to reinforce security of supply. Wind energy is now being perceived as an essential component in Malta's limited portfolio of RE options. Internationally, wind energy technology is currently one of the most cost-effective of all renewable sources. Onshore or land-based wind technology delivers electrical energy at a lower cost than fossil fuel generated electricity and could provide an immediate, affordable and significant start towards meeting Malta's targets. The potential for onshore wind farms is limited by environmental and planning constraints such as visual and landscape impacts, impacts on the natural environment, lack of road infrastructure and interference with airport operations [7]. Government's policy is to favour both onshore and offshore wind farms as long as projects satisfy planning and environmental criteria.

At the lower end of the turbine sizing scale, a small grid-tied wind turbine was installed and tested at the Faculty of Engineering of the University of Malta, Msida, and more recently other small wind turbines were installed by Enemalta Corporation [8] and by WasteServ

Malta Ltd. [9]. There have been a few more small wind turbines (< 20 kW) installed here and there on the islands. To date there are no commercial-scale wind farm projects onshore or offshore. The Government of Malta has publicly expressed an interest in looking at the prospects for close offshore wind farms as announced in the 2009 budget speech [10].

Although more expensive and posing a greater technical and logistic challenge, offshore wind turbine arrays in shallow waters (< 25 metres) are the second best technology option in terms of costs. The sea around Malta is relatively deep close to the shore; the exceptions being certain nearshore coastal areas and a few reefs. It is undeniable that deep sea wind turbine technologies would possibly be more appropriate in the local context as these would offer the possibility of installing wind farms well offshore therefore posing minimised impacts. However, these technologies will not constitute viable short or medium term options until they are commercially proven.

The potential contribution from wind power generation to Malta's electricity requirements is expected to be significant. However the time scales for establishing wind energy projects are not short. This means that Malta should act as soon as possible in implementing RE projects. The implementation of RE generation is now driven by expediency – and is no longer a matter of choice.

2. METHOD OF APPROACH

In order to initiate the site evaluation process, local government authorities commissioned a desk-based assessment of the potential and constraints related to shallow water or nearshore wind farm development on a reef known as *is-Sikka l-Bajda*; literally translated as 'the White Reef'. Earlier works had already identified this offshore site as one warranting further investigation at a time when offshore wind was emerging as a new option for clean energy generation [11, 12]. The current study being presented here consisted of an exercise that was envisaged to:

- Assess concerns in the light of recent developments in wind farm technology and experiences;
- Propose a series of feasible recommendations to resolve and allay popular concerns associated with nearshore offshore wind farm development.

The exploitation of renewable energy sources requires an integrated approach and wind energy technology is an essential component that can be utilised locally. *Is-Sikka il-Bajda* has been considered as one of the better choices for an offshore wind farm project because it offers considerable space with sea depths less than 25 metres for which there is now a mature offshore technology.

2.1. Technical Aspects

2.1.1. Geographical Characteristics

Is-Sikka l-Bajda lies off the north east coast of the main island of Malta in the vicinity of *Għadira Bay* and some 1.5 km to the NE of the closest landfall at *Rdum tal-Madonna* (See Figure 1). *Is-Sikka l-Bajda* has a good exposure to the prevailing north westerly winds and its position off comparatively low lying coastal terrain makes it reasonably exposed from other wind direction sectors.

Inside the 20 metre depth contour, *is-Sikka l-Bajda* has sufficient space for some 30 MW of wind generation capacity. This capacity can be increased to between 70 and 90 MW if the surrounding shallower outcrops in the area up to depths of 25 metres are also considered. No other offshore reef around Malta's shoreline equals this potential in so compact a form and yet

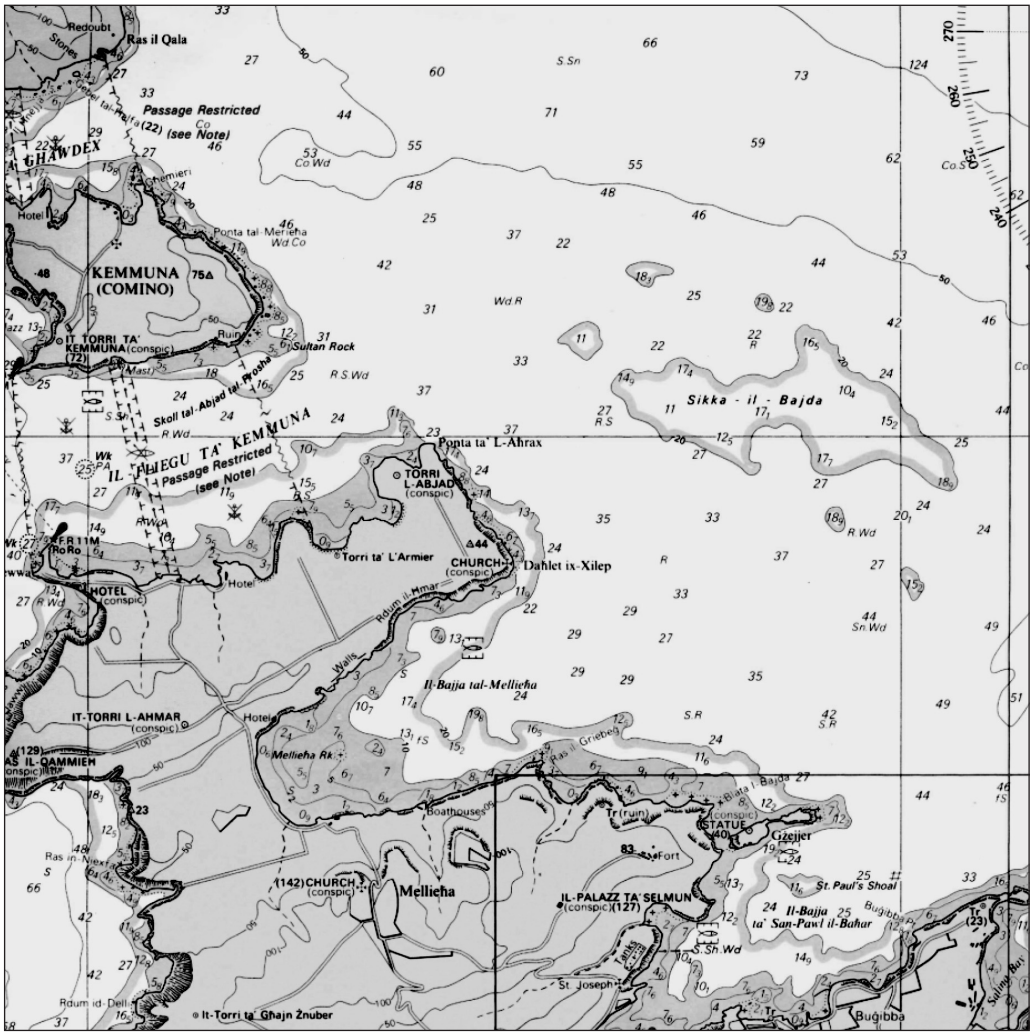

Figure 1: Map showing *is-Sikka l-Bajda* off Malta's north east coast [14].

at a reasonable distance from the islands' shores; a distance that could serve well as a buffer zone. All other reefs abut the shoreline; the only other exception being *Hurd Bank* - although in this latter case, sea depths are substantially greater than on *Sikka l-Bajda*. Wind farm development invariably raises concerns of various nature, particularly from stakeholders and third parties that could, in some way or other, be affected by such development. The key concerns and mitigation are presented in the following sections.

Regarding wind speeds over the reef; actual measurements are not as yet available. A recent study [13] reported an approximate wind speed between 6.5 ms^{-1} and 7.5 ms^{-1} at 70 metres at *is-Sikka l-Bajda*. An 80 metre wind monitoring mast has been installed at *Ponta ta' l-Ahrax*. However a whole year of data would be required to undertake a proper assessment of the long-term wind conditions at the site.

2.1.2. Grid Interfacing Issues

The impact of a sizeable wind farm on the small and isolated local electricity generation network is an important technical issue that requires attention. Detailed grid stability studies and models are required; particularly to establish the size of the spinning reserve required.

Government has expressed an interest in connecting the national grid to the European grid network by means of an undersea cable link with Sicily [10]. Any assessment of wind farm operation in Malta should be made with this option as a future scenario.

Other concerns of technical nature associated with offshore and onshore grid connection works required for such an offshore wind project are the cabling between the individual turbines, between the turbine array and the shore, and from its landfall to a suitable distribution centre. Landing points of the electrical grid connection and distribution cables would require appropriate planning. However, the development of electrical cable-landing points would not be expected to pose an insurmountable hurdle as the size of modern equipment is quite small and compact. Proper design would enable any necessary building structures to fit into the landscape, or even to be located below ground level. The use of overhead pylons and cables should be avoided to remove visual impacts and limit deleterious effects on avian species.

2.1.3. Offshore Wind Farms and Tourism

One of the pillars of the local economy is tourism. The reef in question lies to the north of the predominantly tourist-oriented areas of *Buġibba* and *Qawra*. Consequently, negative landscape or visual impacts of this offshore wind farm may be considered an issue from a tourism point of view. One would envisage that turbine noise from a wind farm is another issue that would warrant attention; especially in view of the fact that over a wider area, this part of the island is dominated by other tourist centres and by eco-trails.

From a technical point of view, the number of wind turbines on *is-Sikka il-Bajda* is limited for technical reasons such as the availability of space on the reef itself and therefore on the number of turbines that could be installed. Regarding visual domination and intrusion, such impacts should be sensitively approached and mitigated through careful selection of the turbines with machine size, number of turbines, aesthetics and array design being given due consideration to impact the marine spaces, the shoreline and its hinterland as little as possible.

Photomontages and other project visualisation tools such as zones of visual influence and video montages can help assess any visual impacts at the project conceptualisation stage, and well before any development is undertaken. An example of typical photomontages is illustrated in Figure 2. The resulting panoramic photos that were generated from locations that could be deemed 'sensitive' vantage points of the offshore farm do not indicate a particularly strong visual impact by the offshore structures. This is due to the fact that the proposed installation site is at least 1.5 km off the nearest landfall at *Rdum tal-Madonna* and 4 to 5 km from the previously mentioned tourist areas of *St. Paul's Bay*, *Bugibba* and *Qawra*. The closest residential zone is on the south east side of *Għadira Bay* at the lower end of the upmarket residential area of *Santa Marija Estate*. In this case, *Is-Sikka l-Bajda* is about 4 km away as the crow flies.

Another key issue for any tourism-oriented country is the fear that visiting tourists may be deterred by the presence of wind farms. Surveys [15 – 16] undertaken to assess the impact of wind farms on tourism in other countries have mostly dispelled the belief that tourists are put off by wind farms, even if they are located in scenic areas. Most respondents to such surveys expressed a positive view of wind farms and said that their presence would not affect the likelihood of their returning to visit the area despite the presence of such installations. Overall, the results indicated that tourists are largely in favour of wind energy and that the presence of wind farms is unlikely to have a negative effect on tourism.

View point – *Ta' L-Aħrax, Marfa*.

View Point – *Ta' Fra Ben, Qawra*.

View point – *Selmun, l/o Mellieħa*.

View point – *Għadira Bay, Mellieħa.*

Figure 2: Scenario 1 for wind farm on *is-Sikka l-Bajda* with 19 x 5 MW wind turbines as perceived from four different vantage points.

Noise is another issue that invariably features in any discussion on wind turbines and wind farms. One would not anticipate noise to be a problem due to the reasonable distances between the wind farm site and the shorelines. Modern large wind turbines, with improved design and sound proofing, have a noise footprint that is restricted to some 350 metres around the farm itself.

Other issues are related to marine leisure sports such as scuba diving, which has been developing as a lucrative component of the local tourist industry in recent years. *Is-Sikka l-Bajda* is not currently used as a dive site because it has been heavily over-fished over the past decades and ship bunkering that is conducted in the area has also probably negatively impacted the sea bed and habitats on the reef. In any case, the presence of a wind farm on this reef should not carry an automatic ban on diving and small-scale fishing activities unless a total exclusion zone is laid out within the perimeter and around the wind farm.

2.1.4. Offshore Wind Farms and Maritime Operations

Malta's strategic position in the central Mediterranean, the fact that a substantial amount of marine traffic exists to, from and between the islands, and the reality that the main inlets and harbours are almost all located on the same north easterly side of the island make the safe coexistence of wind farms in the shallower coastal areas and maritime navigation an important issue. Offshore wind farm operation at *is-Sikka l-Bajda* raises concerns vis-à-vis increased possibility of maritime collision and increased risks to maritime navigation safety. Marine navigation and communications equipment, and interactions with leisure and small scale commercial seaborne traffic are paramount in a maritime nation. Moreover, the reef is located in a ship bunkering zone (Area 1). Ship-to-ship bunkering operations in such a designated area are carried out under particular weather conditions.

It is understandable that maritime operations are significant in the Maltese islands and contribute in no small way to the nation's economy. Consequently safety and security of marine traffic (and related infrastructures such as radar, navigational aids, radio, etc.) in the coastal zone should be given high priority. Experience [17 – 19] with operational or proposed offshore wind farms in areas where maritime activities are also present can be used as models to illustrate the various issues typically encountered in such an environment. This experience also suggests mitigation measures and technical solutions to safeguard leisure and commercial maritime traffic in the vicinity of offshore RE installations.

A need exists for baseline data that would establish maritime traffic patterns on and around *is-Sikka l-Bajda*. Tests to establish interaction between wind turbines and ship borne and shore based navigation and communications equipment, and other investigations of technical and economic nature are critical milestones in the development process that could lead to offshore wind generation technology in Maltese territorial waters. The possibility of redefining or completely relocating the area designated for ship-to-ship bunkering activities should also be tackled.

The coastal area to a distance of 1 nautical mile offshore is considered an important yachting and boating resource. Consequently, an offshore wind farm in a marine area such as *is-Sikka l-Bajda* could be perceived as an obstacle to such recreational marine activities. Private sector initiatives for the development of destination ports and of yacht chartering as distinctive tourism products are also being promoted on the islands. Leisure marine activities by local groups could be affected as may important local and international races and sailing activities.

From a technical point of view, even the complete blocking off of the area identified for a wind farm at *is-Sikka l-Bajda* would not be expected to create an insurmountable obstacle to long distance races as these may be routed further offshore. However, such a zoning constraint may possibly cause difficulty for sailing boats sailing on up-wind tacks on a zigzag course. Concerns raised in this respect would be compounded by the fact that the area around the identified reef is already populated by fish farms to the south and by farms in the South Comino Channel.

Once the wind farm is in operation, it might be possible to allow passage of small craft, motorized or under sail, in the channel between the offshore reef and the closest landfall at *Rdum tal-Madonna*; although there again, this may also prove unfavourable if it is established that such marine traffic causes disruption to avifauna activity in the coastal zone.

2.1.5. Offshore Wind Farms and Aviation

Other concerns could involve aviation traffic and related infrastructure; particularly the effects on radar and navigational aids. A wind farm on *Sikka l-Bajda* is not expected to impact

significantly on such operations although some procedures for helicopters and light aircraft which fly low using visual navigation may need to be modified and notified. Marking the wind turbine structures with paint and illumination by night could reduce risks associated with these activities.

2.2. Environmental Aspects

The *Sikka l-Bajda* site suffers from a number of environmental constraints, including the fact that it was identified by the Structure Plan for the Maltese Islands [20] as a candidate Marine Special Area of Conservation, the fact that the site is a reef, and as such, listed in Annex I of the Habitats Directive, and is characterised mainly by *Posidonia oceanica* settled on matte, with a high bed density and with small, isolated patches of sand and coarse sediment. *Posidonia oceanica* meadows are listed within Annex I of the Habitats Directive, within Annex II of the SPABIM Protocol, within Annex I of the Bern Convention [21] and within Schedule I of LN 311 of 2006 (the latter referring to Maltese legislation).

In addition, the proposed offshore windfarm site is in close vicinity to an area identified as an Important Bird Area, with an adjoining 4-km offshore bird rafting zone. *Is-Sikka il-Bajda* offshore reef is in fact directly opposite (at a distance of 1.5 km) to the *Rdum tal-Madonna* proposed Natura 2000 site - Special Protection Area (SPA, by virtue of the Birds Directive) and Special Area of Conservation (SAC, by virtue of the Habitats Directive). *Rdum tal-Madonna* is designated as an SPA principally for its internationally important colony of Yelkouan Shearwater (*Puffinus yelkouan*) [22].

Malta has around 10% of the world's population of Yelkouan Shearwater and *Rdum tal-Madonna* is the largest colony in Malta, holding about a third of the population. Cory's Shearwater (*Calonectris diomedea*) also breed there and European Storm-petrel (*Hydrobates pelagicus*) have been sighted prospecting and may now be nesting there. Besides, the *Sikka il-Bajda* reef is located at the edge of the Gozo/Malta channel, which is used by migrating waterfowl (and other species), particularly during their northward journey to European breeding grounds. Annex I species such as Ferruginous Duck (*Ayhthya nyroca)*, Garganey (*Anas querquedula)* and Northern Shoveler (*Anas clypeata)* pass in considerable numbers through this 'bottleneck'. The Gozo Channel could also be a prime avenue for migration of bird raptor species (Birdlife Malta, personal communication).

In spite of such environmental constraints, the *Sikka l-Bajda* site has been exposed to a spectrum of different impacts from bunkering and intensive fishing for a number of years. Unfortunately, the environmental impact of both activities has not been assessed and no baseline environmental information for the same site exists.

The environmental impact of an offshore wind farm can be divided into two classes of effects: effects during the construction period and effects during the much longer operation period. Effects during the construction period may further be divided into three categories: destruction, dredging, and disturbance. With the exception of destruction, all these effects may be considered temporary. In contrast, effects during the operation of the wind turbines can be regarded as relatively permanent [23].

A number of putative environmental impacts can be minimised through effective mitigation, such as the deployment of bubble screens to minimise submarine noise generation and of silt curtains to minimise particulate spread, and the avoidance of the bird nesting season for installation of facilities. In addition, the monopile foundation is recommended for the smaller benthic footprint it takes up, that the connecting submarine cable should be laid on the seabed, rather than buried and that unvegetated benthic areas are used where possible for turbine foundations. In spite of such mitigation measures, a number of residual impacts will

still result, including the disturbance to the bird colony and the benthic footprint taken up by the turbine foundations.

In spite of the putative environmental impact of the proposed wind farm at *Sikka l-Bajda*, this can be partly compensated for by the cessation of bunkering activities, with the associated anchoring impacts and release of hydrocarbons, within the area, and by the prohibition of fishing within the same area so that a 'No-Take' Marine Protected Area is effectively declared. Monitoring experience from operational offshore wind farms in the North Sea has also indicated that the submerged components are colonized within a brief period by a diverse fouling community and that the same components act as Fish Aggregating Devices (FAD's), greatly enhancing fish populations in the area [24].

A vast pool of literature from operating offshore wind farms on the environmental impacts of the same farms exists, but the same farms are all located on sand banks whilst the *Sikka l-Bajda* site is a rocky reef. No comparable literature exists for any operational offshore wind farm positioned on bedrock. Similarly, no offshore wind farms have ever been contemplated on seagrass meadows, as at *is-Sikka l-Bajda*, and the implications of such a novel development can only be anticipated with a certain degree of confidence.

2.3. Other Close Offshore Options

2.3.1. Gozo North Shore

The north shore of the smaller island of Gozo has a broad strip of seabed lying inside the 20 m depth contour, running from just west of *Xwieni Bay* to *Ras il-Qala*. The general trend of the first (and wider) section from *Xwieni Bay* to *Mistra Rocks* at the eastern end of *San Blas Bay* is about 30° north of west; that of the narrow second section is close to NW - SE. Closeness to shore and some shielding by land, makes this second section not so suitable as a site for an offshore wind farm. It will not be discussed further here.

The strip between the shoreline and the 20 m depth line from *Xwieni Bay* to *Mistra Rocks* covers an area of 3 km^2 and has a maximum extent from the shore of about 1 km. Although the area is larger than that available at *Sikka l-Bajda*, it is more strung out and as such may require longer turbine-to-shore cabling.

The relative closeness to shore can also create a stronger visual impact; this may be partly offset by using smaller turbines. The only settlements directly on the coast at sea level are *Marsalforn* and its suburb *il-Qbajjar* at the western end of the strip; a careful assessment of the noise footprint of turbines placed at this end is required. The town cores of *Xagħra* and *Nadur* are some 2 km from the shoreline and are unlikely to be affected by noise. The strip running in front of *Ramla Bay (Ramla l-Ħamra.)*, a popular bathing place in summer, has the maximum distance from the shore of the 20 m depth contour. Figure 3 shows a photomontage with 2 MW turbines having a rotor diameter of 82 m and a hub height of 80 m, lying 600 m off the beach at *Ramla l-Ħamra*.

Along most of the length of the strip, the Malta Environment and Planning Authority (MEPA) benthic survey shows a sea bottom covered by meadows of *Posidonia oceanica*. Placing the turbines towards the outer edges of the strip, will minimize, but not eliminate permanent destruction. The shore along the strip is not known to contain any significant breeding colonies of birds. However, the Gozo north shore which, between *Ġordan* lighthouse and *Ras San Dimitri* is an attractive on-shore site for medium-size turbines, is used by seabirds returning to their breeding colonies sited between *Ras San Dimitri* and *Ras il-Wardija*, on the stretch of the Gozo coast facing due west. Actual flight paths have been observed to depend on wind speed: on calm days the birds move along pathways as far as 5 km out to sea; but on days of strong north westerly winds, they tend to hug the shore. In this latter situation the

Figure 3: Photomontage showing an array of 2 MW turbines with a rotor diameter of 82 m and a hub height of 80 m, installed 600 m off the beach at *Ramla l-Ħamra*.

rotors, although presenting a reduced cross-section when facing NW, would present some risk of collision for low-flying birds, at least in the initial period of operation.

An estimate of the wind resource of the eastern half of the north Gozo coast can be obtained from measurements of wind speed taken at the University of Malta station at *Ġordan* lighthouse, situated 2.6 km west of *Xwieni Bay* and 750 m inland. The station anemometer is placed 38 m above ground level, itself 145 m above sea level. For 2006 mean wind velocity was 7.8 ms^{-1}, with a maximum of 11.2 ms^{-1} in March and a minimum of 4.7 ms^{-1} in July. For 2001 and 2007 mean speeds were 8.8 ms^{-1} and 8.2 ms^{-1}. These wind speeds need to be modified on three counts. Hub heights of suitable turbines will be close to 100 m a.s.l., compared to the anemometer height of 183 m a.s.l. This apart, the terrain between the anemometer and the coast 750 m to the north is such as to produce some acceleration once the flow crosses the coast. The sheltering effect with the wind blowing from certain directions should be accounted for. A rough estimate of these combined effects suggests that wind speeds at offshore wind turbine hub height should be about 15% to 30% less than those measured by the anemometer at *Ġordan*. The 2001 mean wind speeds at hub height would then be between 6.6 and 7.6 ms^{-1}.

By scaling year 2001 figures from a detailed comparison between output from the two local power stations and a wind farm off the north Gozo Shore [25], the following result was obtained using modified upper limit *Ġordan* wind speeds. The wind farm output over the year amounted to 86 GWh or 4.2% of 2001 power station output and 3.7% of 2008 output. The actual capacity factor reached 30% for a 32 MW wind farm (16×2 MW).

3. CONCLUSIONS AND RECOMMENDATIONS

The realisation of an offshore wind farm project in the near future would diversify the electricity generation mix and reduce the country's total dependence on fossil fuels. Commercially operated offshore wind farms are zoned in shallow waters at depths of up to

30 metres. Installations in deeper waters (45 metres) are still at a prototype or planning stage and do not have a proven test record yet. To construct and operate an offshore wind farm is an engineering challenge, even more so as offshore wind farms are relatively new, not only to Malta but to the entire Mediterranean. To build an offshore wind farm with deep water technology would bear high technical risks and associated costs.

It is therefore recommended that well proven technologies in shallow waters (< 30 metres) should be considered to reach the nation's immediate requirements. Out of all Maltese offshore sites available within this depth range, *is-Sikka l-Bajda* offers the largest space potential for a reasonably sized wind farm that can contribute significantly. At the same time this site is the most distant from the shoreline and is therefore the one to offer least residual impacts onshore. While problems associated with having a wind farm project at *is-Sikka l-Bajda* are by no means insurmountable, the possibility of having offshore wind farms at other sites, particularly the North Gozo shore, should be kept under review as a possible addition to *is-Sikka l-Bajda*.

Other recommendations should be to have onshore wind farms in areas such as *Baħrija* and *Marfa Ridge* to complement the development at *is-Sikka l-Bajda*. Apart from being less expensive, the timescales for projects at these onshore sites are likely to be shorter than for *Sikka il-Bajda*.

The main conclusions of this study are that *is-Sikka l-Bajda* should be considered as one of the more amenable locations for the siting of a near shore offshore wind farm project. Malta's need to exploit its renewable energy potential in the near future also suggests consideration of Gozo north shore. To this end, it was recommended that a process should be kick started involving the commissioning of the necessary baseline surveys and to engage local planning authorities. These processes should go in tandem with exhaustive educational and public consultation campaigns in order to instil greater public acceptance of wind farm projects.

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